Temas em Saúde
Volume 22, Número 5
ISSN 2447-2131
João Pessoa, 2022

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CORRELATION BETWEEN COVID-19 DEATHS AND SOCIAL INDICATORS IN NORTHEAST BRAZIL

CORRELAÇÃO ENTRE ÓBITOS POR COVID-19 E INDICADORES SOCIAIS NO NORDESTE DO BRASIL

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ABSTRACT - The SARS-CoV-2 pandemic has exposed existing vulnerabilities, particularly in health and economics. It is valid to understand how deaths and comorbidities were influenced by social vulnerability indexes. Assessed the prevalence and correlations between comorbidities related to deaths from COVID-19 and vulnerability index in 6 northeastern states of Brazil. Cross-sectional and retrospective study with secondary data in the period that presented 49% less death in the year 2020. A comparison was made between observed and expected distribution and correlations between deaths, comorbidities and vulnerability indexes. The state of Rio Grande do Norte presented correlations in almost all age groups in both sexes, with moderate and significant correlations ($r= -0.404$; $p< 0.0001$) for males of all ages and males with age ≥60 years ($r = 0.440$; $p<0.0001$). When correlating diabetes with income indexes, we obtained strong correlations for the Gini and Theil-L index ($r= -0.720$; $p= 0.006$), hypertension presented a moderate and significant correlation ($r= 0.593$; $p= 0.047$) with

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the social vulnerability index. It is concluded that the comorbidities involved with the deaths are correlated with social vulnerability.

Keywords: Pandemic; Diabetes; Arterial hypertension; Deaths; Vulnerability.

RESUMO - A pandemia de SARS-CoV-2 expôs vulnerabilidades existentes, particularmente em saúde e economia. É válido compreender como os óbitos e comorbidades foram influenciados pelos índices de vulnerabilidade social. Avaliaram a prevalência e correlações entre comorbidades relacionadas a óbitos por COVID-19 e índice de vulnerabilidade em 6 estados do nordeste do Brasil. Estudo transversal e retrospectivo com dados secundários no período que apresentou 49% menos óbitos no ano de 2020. Foi feita uma comparação entre a distribuição observada e esperada e correlações entre óbitos, comorbidades e índices de vulnerabilidade. O estado do Rio Grande do Norte apresentou correlações em quase todas as faixas etárias em ambos os sexos, com correlações moderadas e significativas (r= -0,404; p< 0,0001) para homens de todas as idades e homens com idade ≥60 anos (r = 0,440; p<0,0001). Ao correlacionar diabetes com índices de renda, obtivemos fortes correlações para o índice de Gini e Theil-L (r= -0,720; p= 0,006), a hipertensão apresentou correlação moderada e significativa (r= 0,593; p= 0,047) com o índice de vulnerabilidade social. Conclui-se que as comorbidades envolvidas com os óbitos estão correlacionadas com a vulnerabilidade social.

Palavras-chave: Pandemia; Diabetes; Hipertensão arterial; Mortes; Vulnerabilidade.

INTRODUCTION

Between February and August 2020, Brazil accounted for 3,278,692 cases of COVID-19, and according to SIVEP-Gripe data, there were 576,799 hospital admissions. During the month of May 2020, these hospitalizations intensified in the North, Northeast and Southeast regions [1]. According to data from the Ministério da Saúde, until January 24, 2021, the Northeast region had 2,105,714 confirmed cases of COVID-19 with 50,659 deaths recorded [2].

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The high number of cases caused an overload in the health systems, an increase in the demands for care and beds in hospitals and exhaustion of health professionals [1]. The heterogeneity between the regions of Brazil, in the social, economic and health spheres, may have aggravated these disparities in access to health, affecting the most vulnerable population [3].

In this context, the Social Vulnerability Index (SVI) is a tool to classify the population, during the pandemic, according to various social and economic indicators, urban infrastructure and health services. Studies suggest that regions with greater risks to vulnerability and social inequalities are directly linked to the mortality and lethality rates of COVID-19 [4].

In addition to the SVI, the HDI (Human Development Index) makes it possible to quantify the capacities of individuals to expand their freedoms according to their opportunities [5]. Associated with the low HDI, social, demographic and economic determinants intensify the impacts of the pandemic and the measurement of vulnerability indexes facilitates the emergence of measures adopted to reduce the susceptibility of vulnerable areas in the state of Ceará [6].

This research suggests the analysis of correlations between the social vulnerability indexes of the states of the Northeast region of Brazil in relation to the prevalence of comorbidities of deaths by COVID-19, in order to improve the understanding of these diseases in relation to the pandemic, as well as to demonstrate the reality of the pandemic in this region and proposes the need for public policies to face the socio-economic vulnerability in the confrontation of health problems caused by the pandemic.

MATERIALS AND METHODS

This is a retrospective cross-sectional study using secondary data from the health secretaries of 6 states in the Northeast region in the period in which there were 49% fewer deaths compared to the peak of the moving average in 2020. Sample consisted of all confirmed COVID-19 deaths in the states participating in the study. This research was not submitted to the Research Ethics Committee (REC), since secondary data were used. In addition to this information, raw data were collected: Social Vulnerability Index (SVI), Municipal Human Development Index (MHDI), GINI index, Theil-L index, aging rate.

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For data normalization, the *Kolmogorov-Sminov* test was applied. After normalization, the chi-square test was used to compare the observed distribution. To perform the correlations between deaths and vulnerability indexes, and comorbidities and incomes, vulnerability and development indexes, the Spearman test was used considering a weak (r = 0.1 to 0.3), moderate (r = 0.4 to 0.6) and strong (r = 0.7 to 1.0) correlation, taking into account $p<0.05$.

RESULTS

The six states of the Northeast region analyzed had a total of 770,226 confirmed cases of COVID-19 after a 49% drop in deaths, of these positive cases, 15,512 corresponded to the total number of deaths in these states. Of the 15,512 deaths, 8,221 were male and 7,282 were female, and 2 had unidentified sex.

In the distribution by frequency, we can observe the total number of deaths by each state, highlighting the states of Bahia with 40.83% (6,332), Maranhão with 16.69% (2,589) and Rio Grande do Norte with 16.31% (2,530) (Table 1).

Table 1 - Prevalence of deaths from COVID-19 in the states of the Northeast region, with a decline of 49% of deaths in the year 2020.

TOTAL STATES	N	%
Maranhão	2589	16,69
Rio Grande do Norte	2530	16,31
Paraíba	1817	11,72
Sergipe	517	3,33
Alagoas	1725	11,12
Bahia	6332	40,83
Total	15510	100

Caption: N: absolute frequency; (%): relative frequency.

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Regarding comorbidities, we can observe that in the state of Maranhão, Systemic Arterial Hypertension and Diabetes were prevalent, with values of 37.13% (1,697) and 25.65% (1,172) respectively. In Rio Grande do Norte, Diabetes and Heart Disease were the two most prevalent comorbidities, with respect to Heart Disease, the state presented values of 47.40% (18,714) and 28.55% (11,266) for Diabetes.

The state of Paraíba presented as prevalent comorbidities Diabetes and Hypertension. For Diabetes 21.53% (842) and for Hypertension the state presented 20.76% (812). In Sergipe, Diabetes and Hypertension were the prevalent comorbidities, 24.44% (553) in relation to diabetes and 31.06% (703) for hypertension.

Alagoas showed a prevalence for the comorbidities of diabetes and heart disease. For diabetes, the value was 30.91% (451) and in relation to heart disease, 21% (306). The state of Bahia presented Diabetes and Hypertension as prevalent comorbidities, with 24.9% (2,410) and 26.84% (2,603) respectively (Table 2).

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Table 2 - Prevalence of comorbidities related to deaths from COVID-19 in the states of the Northeast region, with a decline of 49% of deaths in the year 2020.

	Maranhão		Rio Grande do Norte		Paraíba		Sergipe		Alagoas		Bahia	
COMORBIDITIES	N	%	N	%	N	%	N	%	N	%	N	%
Heart disease	359	7,85	18714	47,4	564	14,42	243	10,74	306	21	1468	15,13
Diabetes	1172	25,65	11266	28,55	842	21,53	553	24,44	451	30,91	2410	24,9
Kidney disease	178	3,9	1447	3,66	124	3,17	99	4,37	46	3,15	551	5,68
Hypertension	1697	37,13	100	0,3	812	20,76	703	31,06	173	11,86	2603	26,84
Hypertension, diabetes	333	7,28	49	0,12	415	10,61	230	10,16	94	6,44	891	9,18
Obesity	131	2,90	134	0,33	134	3,42	140	6,18	26	1,80	448	4,61
Oncological / neoplasm	116	2,53	0	0,00	46	1,17	78	3,44	10	0,70	278	2,86
Pneumopathy	35	0,76	0	0,00	0	0,00	26	1,14	3	0,20	12	0,12
Respiratory diseases	0	0,00	5699	14,44	157	4,01	5	0,20	57	3,90	365	3,76
Asthma	0	0,00	0	0,00	0	0,00	16	0,70	151	10,35	5	0,05
DPOC	0	0,00	0	0,00	0	0,00	58	2,56	0	0,00	16	0,16
Immunosuppression	0	0,00	1465	3,71	48	1,22	37	1,63	14	0,95	103	1,06
Chromosomal diseases	0	0,00	588	1,49	344	8,80	0	0,00	1	0,06	2	0,02
Hematological disease	0	0,00	0	0,00	13	0,30	3	0,13	0	0,00	49	0,50
Neurological disease	183	4	0	0,00	271	7,00	21	1,00	2	0,13	165	1,70
Smoking	0	0,00	0	0,00	44	1,12	3	0,13	1	0,06	94	0,96
Metabolic disease	0	0,00	0	0,00	22	0,56	0	0,00	0	0,00	34	0,35
Alcoholism	0	0,00	0	0,00	10	0,25	0	0,00	1	0,06	4	0,04

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Others	366	8	0	0,00	65	1,66	48	2,12	123	8,43	202	2,08
TOTAL	4570	100	39462	100	3573	100	2263	100	1459	100	9700	100

Caption: N: absolute frequency; (%): relative frequency; considering a value of $p<0.05$; $p<0.001$. Chi square test. Each state presents data on comorbidities differently.

When analyzing the prevalence of deaths from COVID-19 in relation to the age group in the states, in the state of Maranhão, the prevalent age groups were 60 to 69 years old, with a value of 23.22% (601). In the age group from 70 to 79 years old, this state presented 28.36% (734) and in the age group >80 years old it had 29.29% (758).

The state of Rio Grande do Norte presented prevalence in the age groups of 20 to 39 years, 40 to 49 years and 50 to 59 years. With values of 23% (9,146), 18.83% (7,501) and 19.33% (7,699) respectively.

Regarding the state of Paraíba, the age groups from 60 to 69 years old, 70 to 79 years old and >80 years old stand out, 19.06% (355), 24.30% (440) and 31.30% (567) respectively.

In the state of Sergipe, the prevalent age groups were 60 to 69 years old, 70 to 79 years old and >80 years old. The age group from 60 to 69 years old presented 21.50% (380). In the age group 70 to 79 years, 24.50% (434) and in the age group >80 years were observed 23.80% (422).

Alagoas also presented a similar prevalence to other states, in the age groups of 60 to 69 years, 70 to 79 years and >80 years with values corresponding to 13% (425), 9.11% (461) and 6.30% (380).

The state of Bahia also had a prevalence in the age groups of 60 to 69 years, 70 to 79 years and > 80 years, with values equal to 21.47% (1,641), 24.19% (1,849) and 28.66 (2,191) respectively (Table 3).

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Table 3 - Prevalence of deaths from COVID-19 by age group in the states of the Northeast region of Brazil, with a 49% decline in deaths in 2020.

	Maranhão		Rio Grande do Norte		Paraíba		Sergipe		Alagoas		Bahia	
	N	%	N	%	N	%	N	%	N	%	N	%
< 1 year old	7	0,27	80	0,20	9	0,49	11	0,62	1	0,20	18	0,20
1 to 4 years old	6	0,23	140	0,35	1	0,05	4	0,22	2	0,35	3	0,03
4 to 14 years old	3	0,11	433	1,08	0	0,00	15	0,84	7	1,08	17	0,22
15 to 19 Years old	10	0,38	3383	8,49	3	0,16	8	0,45	7	8,49	19	0,24
20 to 39 Years old	89	3,43	9146	23,00	88	4,90	111	6,26	82	23,00	371	4,90
40 to 49 Years old	122	4,71	7501	18,83	127	7,00	142	8,01	132	18,80	586	7,66
50 to 59 Years old	258	10,00	7699	19,33	220	12,20	244	13,80	224	19,30	950	12,43
60 to 69 Years old	601	23,22	5161	12,96	355	19,6	380	21,50	425	13,00	1641	21,47
70 to 79 Years old	734	28,36	3631	9,11	440	24,30	434	24,50	461	9,11	1849	24,19
> 80 years old	758	29,29	2517	6,30	567	31,30	422	23,80	380	6,30	2191	28,66
Undefined	0	0,00	141	0,35	1	0,05	0	0,00	4	0,35	0	0,00
TOTAL	2588	100	39832	100	1811	100	1771	100	1725	100	7645	100

Caption: N: absolute frequency; (%): relative frequency; considering a value of $p<0.05$; $p<0.001$. Chi-square test.

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Table 4 presents the result of the correlations between the total number of deaths with the indicators of social vulnerability, population density, MHDI, SVI, GINI Index, Theil-L Index, aging rate, weeks for 49% less than death and 1st death at peak. Although few of these correlations expressed a statistically significant result, the aging rate presented a very weak positive correlation, while the 1st death at the peak of the disease in the territory of Northeast Brazil presented a moderate positive correlation with the total number of deaths during the period studied. These results seem to represent how the older population can influence the totality of deaths, as well as the report of the 1st death in the peak period of the disease. The GINI index (r= 0.862) and the Theil-L index (r= 0.863) showed a positive and strong correlation with the total number of deaths in a significant way (p= 0.0124; p= 0.0123, respectively). Thus, it can be said that the total number of deaths recorded by COVID-19 during the period studied is directly linked to the conditions of concentration and income distribution among the states of Brazilian Northeast (Table 4).

In addition, Table 4 presents the relative frequency correlations with the comorbidities, a strong and significant negative correlation (r = -0.720; p = 0.006) was found for the diabetes comorbidity with the Gini index and the Theil-L index (r= -0.720; p = 0.006) on the other hand, there was no significant correlation between the social vulnerability index and the municipal development index. Hypertension showed a significant moderate correlation (r = 0.593; p = 0.047) with the social vulnerability index. In this way, we can say that the comorbidities of diabetes and hypertension are linked to the conditions of social inequality and income distribution in the Northeast states of Brazil (Table 4).

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Table 4 - Correlation between the relative frequency of Diabetes, Hypertension and Heart Disease comorbidities of COVID-19 death cases in Northeast Brazil and the social vulnerability indexes in decline of 49% of death in the year 2020.

TOTAL NO. OF DEATHSvs.			Value of *r*	Value of *p*
Demographic density			-0,471	0,285
MHDI			0,027	0,953
SVI			0,079	0,866
GINI Index			0,862	0,012
THEIL-L Index			0,863	0,012
Aging rate [2010]			0,130	0,781
Weeks for 49% less death			-0,005	0,990
1st death at peak			0,603	0,151
DIABETES vs.	**GINI**	**THEIL-L**	**SVI**	**MHDI**
Value of *r*	-0, 720	-0, 720	0, 056	-0, 197
Value of *p*	0, 006	0, 006	0, 876	0, 515
HYPERTENSION vs.				
Value of *r*	0, 524	0, 524	0, 593	-0, 197
Value of *p*	0, 089	0, 089	0, 047	0, 515
HEART DISEASE vs.				
Value of *r*	-0, 481	-0, 481	-0, 538	0, 226
Value of *p*	0, 077	0, 077	0, 063	0, 478

Caption: MHDI (Municipal Human Development Index), SVI (Social Vulnerability Index). Considering a value of $p<0.05$; $p<0.01$ and $p<0.001$. Spearman test r, considering weak correlation (r=0.1 to 0.3); moderate (r=0.4 to 0.6) and strong (r=0.7 to 1.0) with $p<0.05$.

When analyzing the correlation of prevalent comorbidities between states with age in general and age ≥ 60 years by sex, a significant weak correlation (r = 0.121; p =

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0.001) was found for deaths of the sex male ≥ 60 years in the state of Alagoas. In the state of Bahia, in relation to diabetes comorbidity, there was a weak and significant correlation (r = 0.110; p = 0.0006) for males ≥ 60 years, a very weak and significant correlation for females of all ages (r = 0.045; p = 0.024) and a very weak and significant correlation (r = 0.045; p = 0.048) for females ≥ 60 years. For the comorbidity Hypertension, the state of Bahia presented a very weak and significant correlation (r= -0.097; p<0.0001) for males of all ages and also for females of all ages (r = - 0.067; p = 0.0008).

In the state of Maranhão, the correlations found were weak and significant in relation to males ≥ 60 years (r = 0.101; p = 0.0006) and females ≥60 years (r = 0.141; p = 0.0001) in relation to comorbid diabetes. Regarding the comorbidity Hypertension, the state showed a very weak correlation for males of all ages (r = -0.130; p<0.0001) and for females of all ages (r = -0.146; p<0 .0001).

Sergipe showed weak and significant correlations in relation to diabetes for females of all ages (r = 0.110; p= 0.025) and females ≥60 years (r = 0.111; p = 0.044). For the comorbidity of hypertension, the state showed weak and significant correlations for females of all ages (r = -0.220; p<0.0001) and females ≥60 years (r = -0.151; p = 0.006).

Correlations in the state of Paraíba were weak and significant for males and females ≥ 60 years (r = 0.111; p = 0.003; r = 0.123; p = 0.001 respectively). Regarding hypertension, the state showed a very weak correlation for p males of all ages (r = -0.065; p = 0.044) and a significant weak correlation (r = -0.125; p = 0.0002) for female gender of all ages.

The state of Rio Grande do Norte presented a weak and significant correlation (r = -0.219; p<0.0001) for the comorbidity of Heart disease for males of all ages, a very weak correlation for males ≥60 years (r= -0.058; p<0.0001). As for females for all ages, there was a weak correlation (r=-0.303; p<0.0001) and a very weak correlation (r=-0.065; p<0.0001) for those aged ≥60 years. Regarding diabetes, the state showed a moderate and significant correlation (r = -0.404; p<0.0001) for males of all ages and ≥60 years (r = 0.440; p<0.0001). And significant weak correlation (r = -0.277; p<0.0001) for females of all ages (Table 5).

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Table 5 - Correlation of prevalent comorbidities in cases of COVID-19 deaths according to sex and age in Northeast Brazil, with a 49% decline in death in 2020.

	Heart disease				**Diabetes**				**Arterial hypertension**			
	Male		**Female**		**Male**		**Female**		**Male**		**Female**	
	r Value		*r* Value	*p* Value	*r Value*	*p* Value	*r* Value	*p* Value	*r Value*	*p* Value	*r* Value	
Alagoas												
All ages	0,054		-0,050	0,168	-0,013		0,673	-0,034	0,347	-	-	-
≥60 years old	0,467		0,001	0,967	0,121		0,001	0,004	0,918	-	-	-

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Bahia										
All ages	-	-	-	0,028	0,117	0,045	0,024	-0,097	< 0,0001	-0,067
≥60 years old	-	-	-	0,110	< 0,0001	0,045	0,048	0,021	0,314	-0,011
Maranhão										
All ages	-	-	-	0,038	0,150	0,028	0,391	-0,130	< 0,0001	-0,146

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≥60 years old	-	-	-	0,101	0,0006	0,141	0,0001	-0,038	0,196	-0,029
Sergipe										
All ages	-	-	-	-0,009	0,834	0,110	0,025	-0,051	0,258	-0,220
≥60 years old	-	-	-	0,077	0,138	0,111	0,044	-0,041	0,428	-0,151
Paraíba										
All ages	-	-	-	0,062	0,055	0,039	0,253	-0,065	0,044	-0,125

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≥60 years old	-	-	-		0,111	0,003	0,123	0,001	0,056	0,135	-0,074
Rio Grande do Norte											
All ages	-0,219	< 0,0001	-0,303	< 0,0001	-0,404	< 0,0001	-0,277	< 0,0001	-	-	-
≥60 years old	-0,058	< 0,0001	-0,065	< 0,0001	0,440	< 0,0001	-0,018	0,168	-	-	-

Caption: Considering $p<0.05$; $p<0.01$ and $p<0.001$. Spearman test r, considering weak correlation ($r=0.1$ to 0.3); moderate ($r=0.4$ to 0.6) and strong ($r=0.7$ to 1.0) with $p<0.05$.

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DISCUSSION

The COVID-19 pandemic until February 2021 caused more than two million deaths worldwide and more than two hundred thousand deaths in Brazil. The Northeast region had a total of 51,968 deaths in this period. In the states of the present study, it was observed that in the Northeast region, deaths are prevalent in older age groups and in the presence of comorbidities. Suggesting comorbidities as a risk factor for severe disease and progression to death [7].

It was observed that diabetes and hypertension are the prevalent comorbidities, a result similar to the study by Zhang [8] *et al* (2020) that showed pre-existing diseases as predictors of death, especially among patients with severe COVID-19. Tamayo [9] *et al* (2020), bring diabetes with a higher mortality rate (16.3%) compared to those who do not have diabetes (0%). Thus, it is important to address the profile of these comorbidities, since individuals with chronic diseases are ten times more likely compared to those who do not have pre-existing diseases [10].

In addition to comorbidities, age is considered an important factor for deaths, Meng [11] *et al* (2020) affirm that people over the age of 60 are part of the risk group to develop complications from COVID-19 and evolve to death. This corroborates with our results, since the age group from 60 years old was more prevalent among the analyzed states. This finding is justified by Barbosa [12] *et al* (2020) who point out this group as a vulnerable population, due to factors such as income and education, in addition to restricted access to health services, so they are more susceptible to contamination, severity and deaths. These results differ from our study in relation to the state of Rio Grande do Norte, which presented prevalence for the comorbidity of heart disease and prevalence in the age group from 20 to 59 years. Heart disease is commonly associated with COVID-19 and is more frequent in older patients due to reduced aging-related immunity, thus providing higher rates of cardiac risk in older adults [13]. On the other hand, Silva [14] (2020) affirms that adults up to 59 years of age are more impacted, as they are more productive in the labour market, and consequently are more exposed to contamination, as they use public transport.

In view of the above, the elderly population has the highest mortality rates, which is justified by the aging factor, reduced immunity, but also by the high prevalence of chronic diseases when compared to the younger population [15],

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confirming the data of our study, that diabetes and hypertension were the prevalent diseases as well as the age group from 60 years old in the states of the northeast region.

The literature addresses controversial positions regarding the use of drugs that treat these chronic diseases, such as Angiotensin Converting Enzyme Inhibitors (ACEI) and Angiotensin II Receptor Blockers (ARBs). Pollitt [16] *et al* (2020) say that these drugs are responsible for stimulating ACE and facilitating viral uptake, increasing the risk of severe infection in people with pre-existing diseases, since ACE2 is the main source of binding between the virus and the human organism, as it is present in almost all human tissues [17, 18].

As also Petto [19] *et al* (2021) speculate that by inactivating ACE2, the virus provides greater activity of ACE1, of the Ang II receptors of the Renin Angiotensin System (RAS) that favors the evolution of diseases and consequently worsen the prognosis of infected patients, since hypertensive and diabetic patients show an increase in inflammatory markers and stimulate the disease cycle with the RAS resulting from the inflammatory process [20,21], responsible for reducing the immune reserve, thus the virus installs easily and aggressively [19,22].

The RAS imbalance caused by the decrease in the production of Ang I-VII molecules and the increase in Ang II favors inflammatory cascades and thrombotic events [23,24]. This alteration in the RAS is justified by the oxidative stress and inflammatory condition found in the pathological conditions of comorbidities [25]. Consequently, these inflammatory mechanisms provide the greatest susceptibility to severe infection and greater impairment [26].

On the other hand, treatment with these drugs has been proposed as a strategy against COVID-19 [27]. Imai [28] *et al* (2005) concluded that blocking the RAS in an animal model reduced significant lung injury caused by SARS-CoV, which also uses ACE2 as a binding source. Bozkurt [29] *et al* (2020) suggest that ACE inhibitors could benefit patients with SARS-CoV-2, but warns of the lack of evidence proving the benefits and harms of using these drugs. Therefore, it is recommended to continue treatment with these drugs, as they do not have sufficient evidence to discontinue use because of COVID-19 infection.

In this way, better monitoring of these people with diabetes and arterial hypertension is necessary, these studies corroborate and justify our results in relation to the profile and prevalence of comorbidities and age group of deaths from COVID-19 in the Brazilian Northeast. Because the condition of comorbidity is considered a risk factor

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for deaths from the disease, since there are significant correlations between these diseases and age group.

As shown by Almeida [30] *et al* (2020), moderate correlation for deaths over 50 years regardless of sex and strong for age over 60 years with diabetes comorbidity, and low correlation for hypertension regardless of sex in the state of Sergipe.

Socioeconomic conditions are considered an important risk factor among states, indicating unequal relationships and social vulnerability. It is justified by the failure to follow social isolation measures against the transmission of COVID-19. The MHDI is responsible for indirectly measuring the difficulties in remaining in social isolation, since they need to go out to seek sustenance, so the levels of income concentration along with schooling are considered determining factors [31].

When correlating the number of deaths with the Municipal Human Development Index (MHDI) there was no significant correlation, but studies show that the neighborhoods that have the highest number of COVID-19 cases have a high MHDI, but when compared to more peripheral neighborhoods it is the mortality that presents higher levels [32].

This vulnerability condition reflects our findings that deaths are directly related to income concentration and distribution, showing a positive and strong correlation with the Gini index ($r = 0.862$; $p = 0.012$) and with the Theil index. -L ($r = 0.863$; $p = 0.012$). There are no studies that show this correlation, but it is clear that the low-income population is vulnerable to deaths, since they do not comply with preventive measures, access to health is more limited and they need to use public transport to work [33].

As well as comorbidities are associated with indices that reflect social vulnerability, diabetes in the Northeast region showed a high and significant correlation with the indexes of income distribution and concentration, and arterial hypertension showed a moderate and significant correlation with the social vulnerability index. This leads us to the perception of the influence of social and financial conditions as determining factors for the number of deaths, bringing the perception that those with lower income will always be vulnerable [34].

It is important to emphasize the relevance of this study for bringing important information, with still scarce correlations on the current theme of the pandemic in the Northeast region of Brazil, in this way it is possible that the values of the indexes referring to the concentration and distribution of income, as well as the social vulnerability index directly influence comorbidities and deaths from COVID-19, being

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able to guide public policies that can mitigate the impact of the pandemic on these vulnerable groups.

CONCLUSIONS

We can conclude that mortality from COVID-19 was more prevalent in males and in age groups greater than or equal to 60 years. In the Northeast region of Brazil, the most prevalent comorbidities in cases of death during the study period were DM, SAH and heart disease. A significant correlation was found between comorbidities and age, as well as the indexes of social vulnerability and social inequality may indicate that the most economically vulnerable people were more likely to die from COVID-19 in the period studied.

Author Contributions: Conceptualization, AK, CE and MC; Formal Analysis: EC; Acquisition of Financing: AK; Research: AK, CL and BA; Methodology: AK, CE and MC; Project administration: CE; Resources: EC; Supervision: CE and AK; Validation: AK, CE and MC; Visualization: BA and AK; Writing –Original draft: AK, CE, MC and BA; Writing – Proofreading and Editing: AK, BA and NA.
Funding: This research was funded by Fundação de Apoio à Pesquisa e à Inovação Tecnológica do from Sergipe State.
Institutional Review Board Statement: Ethical review and approval were waived for this study due to the use of secondary data.
Informed Consent Statement: Not applicable.
Data Availability Statement: This data can be found here: [http://www.dados.al.gov.br/dataset/painel-covid19-alagoas; http://www.atlasbrasil.org.br/consulta; http://www.dados.al.gov.br/dataset/painel-covid19-alagoas; https://www.conass.org.br/painelconasscovid19/; https://www.ibge.gov.br/cidades-e-estados. Accessed at September 2020; https://www.ibge.gov.br/cidades-e-estados. Accessed at September 2020; https://covid.saude.gov.br/; http://www.ipea.gov.br/portal/images/stories/PDFs/comunicado/120925_comunicadodoipea155_v5; https://www.saude.ma.gov.br/boletins-covid-19/; https://portalarquivos2.saude.gov.br/images/pdf/2020/janeiro/23/Boletim_epidemiologico_SVS_04.pdf; https://portalarquivos2.saude.gov.br/images/p df/2020/janeiro/28/

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Boletim-epidemiologico-SVS-28jan20.pdf; https://covid.saude.gov.br/; https://superset.plataformatarget.com.br/superset/dashboard/microdados/; https://portalcovid19.saude.rn.gov.br/medidas/boletinsepidemiologicos/; https://todoscontraocorona.net.br/ ; https://www.who.int/docs/default-source/coronaviruse/who-china-joint-mission-on-covid-19—final-report-1100hr-28feb2020-11mar-update.pdf?sfvrsn=1a13fda0_2&download=true; http://www.who.int/csr/sars/country/table2004_04_21/en/index.html; http://www.emro.who.int/health-topics/mers-cov/mers-outbreaks.html; http://www.who.int/emergencies/mers-cov/en/; https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200121-sitrep-1-2019-ncov.pdf]

Acknowledgments: We would like to thank the group Pesquisa do Laboratório de Estudos Biológicos e Produtos Naturais.

Conflicts of Interest: The authors declare no conflict of interest.

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